Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Period: \_\_\_\_\_

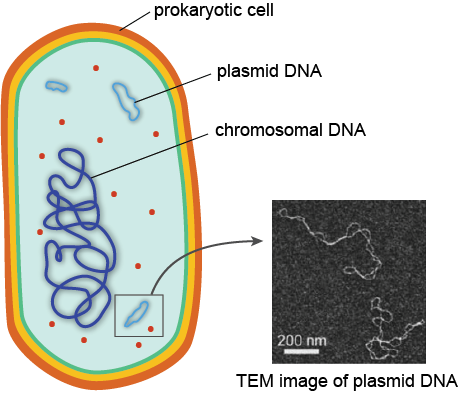
**Unit 4 Notes, Part A: The Cell Cycle and Mitosis (Chapter 12)**

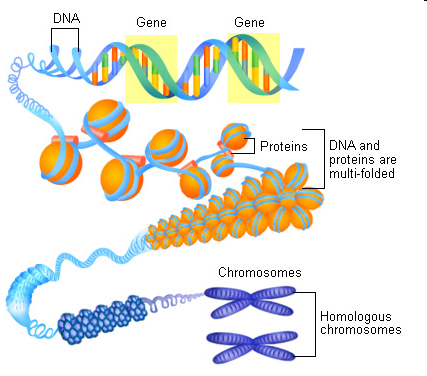
Ms. Ottolini, AP Biology, 2012-2013

**Notes**

**Organization of Genetic Material**

1. The cell’s total library of DNA is called its \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.



1. The \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ genome is typically a single, long DNA molecule. In prokaryotic cells, there are also small circles of DNA called \_\_\_\_\_\_\_\_\_\_\_\_\_\_ that are separate from the main genome.
2. A eukaryotic genome is much larger than a prokaryotic cell; a human cell generally contains \_\_\_\_\_\_\_ of DNA.
3. What must happen to the DNA in a cell before that cell can divide in order to reproduce?
4. In a human cell that is not actively dividing, DNA is typically found as \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, a complex of DNA and associated protein molecules called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. What is the role of the histone proteins?
5. In a human cell that is preparing for division or actively dividing, DNA is found as \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, which are strings of chromatin that are super-coiled. Why does the DNA organize itself this way during cell division?

7) Each side of an X-shaped chromosome is made of an identical copy of DNA called a \_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_. During cell division, these copies must be divided to give each \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ a full \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. The chromosomes are connected at a region called the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. The proteins in the centromere that are attachment sites for mitotic spindle fibers (chromatid-separating structure used during cell division) are called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

1. What is the difference between somatic cells and gametes? How many chromosomes are found in human somatic cells vs. gametes?

**The Cell Cycle**

9) The ability to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is one characteristic of living things.

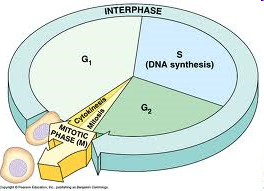
10) Not all cell division helps an organism to reproduce. See below for a list of the functions of cell division in unicellular vs. multicellular organisms.

**Notes**

|  |  |
| --- | --- |
| **Unicellular Organisms** | **Multicellular Organisms** |
| * Reproduction only | * Replacing cells that die from normal wear and tear * Growth and development from a single fertilized egg (zygote) * Reproduce asexually (ex: plants can grow by “grafting” / “cutting”) |

11) Steps of the cell cycle (all the events in the life of a cell)

* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ comprises 90% of the cell cycle. In this portion of the cell cycle, the cell is not dividing and is going through all its normal activities. During this phase, the DNA is spread out as \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, and the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ / \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ are visible. Interphase is divided into three phases (and sometimes a fourth). These phases are described below.

**G1 phase** (first gap): the cell grows by producing \_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_

**S phase** (synthesis): the cell makes a copy of its DNA

**G2 phase** (second gap): the cell makes molecules / organelles needed for cell division

Ex:

**G0 phase:** cell leaves the normal cell cycle and stops dividing

Ex:

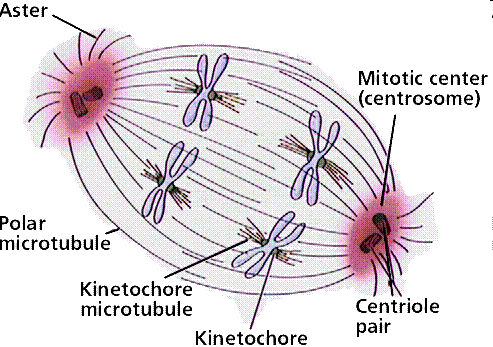
* Interphase is followed by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, the division of a cell’s nucleus and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, the division of a cell’s cytoplasm. At the end of the cell cycle, two daughter cells are produced that then enter the cell cycle again.
* A typical human cell divides around every 24 hours.

**M phase** < 1 hour

**S phase** = 10-12 hours

**G1 and G2 phase** = the rest of the time (G1 length is the most variable…depends on the type of cell… ex: skin cells have shorter cell cycles than muscle cells)

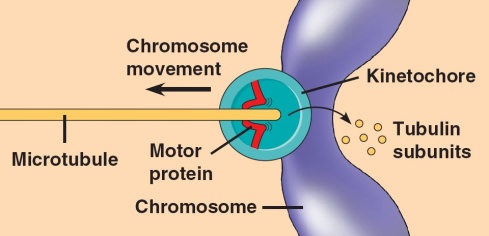
**Cellular Equipment Needed for Division**

* The \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is a structure that forms in the cytoplasm during the beginning stage of mitosis (prophase); it is used to separate sister chromatids during mitosis
* The spindle is assembled from elements of the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_called microtubules. The spindle fibers elongate by adding \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ subunits.

**Notes**

* Assembly of microtubule fibers starts in the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, AKA the “microtubule organizing center.” In animal cells, organelles called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ are found at the center of the centrosome, but they do not seem to be necessary for spindle formation.
* Possible mechanisms for how the mitotic spindle works:

1. Chromosomes are “reeled in” by the shortening of microtubules at the poles
2. Evidence suggests that microtubules shorten at the end holding the chromosome as \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ on the kinetochore “walk” chromosomes along microtubules toward the poles
3. Motor proteins also walk along \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ microtubules to lengthen / move them apart and elongate the cell.

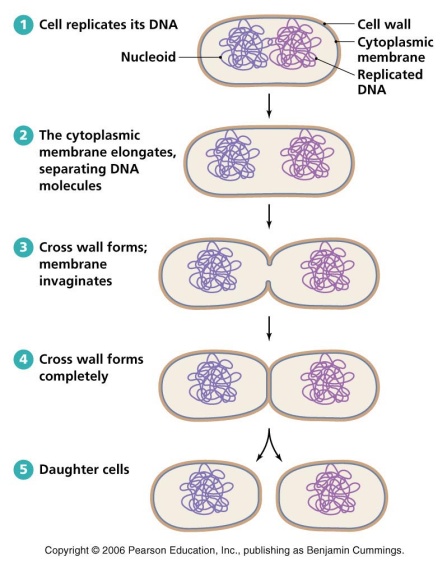


**The Stages of Mitosis**

|  |  |  |
| --- | --- | --- |
| **Stage Name** | **Description** | **Picture** |
| Prophase | * chromatin becomes tightly coiled into \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ * \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ disappear * Mitotic spindle begins to form… microtubules that extend from the centrosomes = \_\_\_\_\_\_\_\_\_\_\_\_\_ * Centrosomes move toward \_\_\_\_\_\_\_\_ of cells |  |
| Prometaphase | * \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ fragments (breaks apart) * Microtubules attach to centrosome at kinetochore proteins * Non-kinetochore fibers don’t attach to chromosomes | http://www.edupic.net/Images/Mitosis/prometaphase.png |
| Metaphase | * Longest dividing phase * Spindle fibers push chromosomes to line up along an imaginary plane at the equator (center of the cell) called the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |  |
| Anaphase | * Shortest dividing phase * \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ separate and move to opposite poles of the cell |  |
| Telophase | * AKA “reverse \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_” * Two daughter \_\_\_\_\_\_\_\_\_ begin to reform * Nuclear envelope reforms * Chromosomes spread out as \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ * Spindle / centrosomes disappear |  |
| Cytokinesis | * Cytoplasm splits * Usually starts in late \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ * The \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ splits animal cells (actin and myosin proteins interact to contract a ring around the membrane) * The \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ splits plant cells (cell wall materials are deposited by vesicles from the Golgi) |  |

**Evolution of Mitosis**

**Notes**

* Mitosis may have had its origins in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, a method used by bacteria to reproduce
* In binary fission…

1. Bacteria have a large circular chromosome
2. Replication of DNA (before division) starts at one point, the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and moves in both directions
3. The cell elongates
4. The \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ grows inward
5. The cell is divided into two daughter cells, each with a complete \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
6. No spindle or microtubules; several proteins play a role in this process (you do not need to know their names, but know that they are related to tubulin and actin—two cytoskeleton proteins—and they are similar to eukaryotic proteins…hence the connection between binary fission and mitosis!